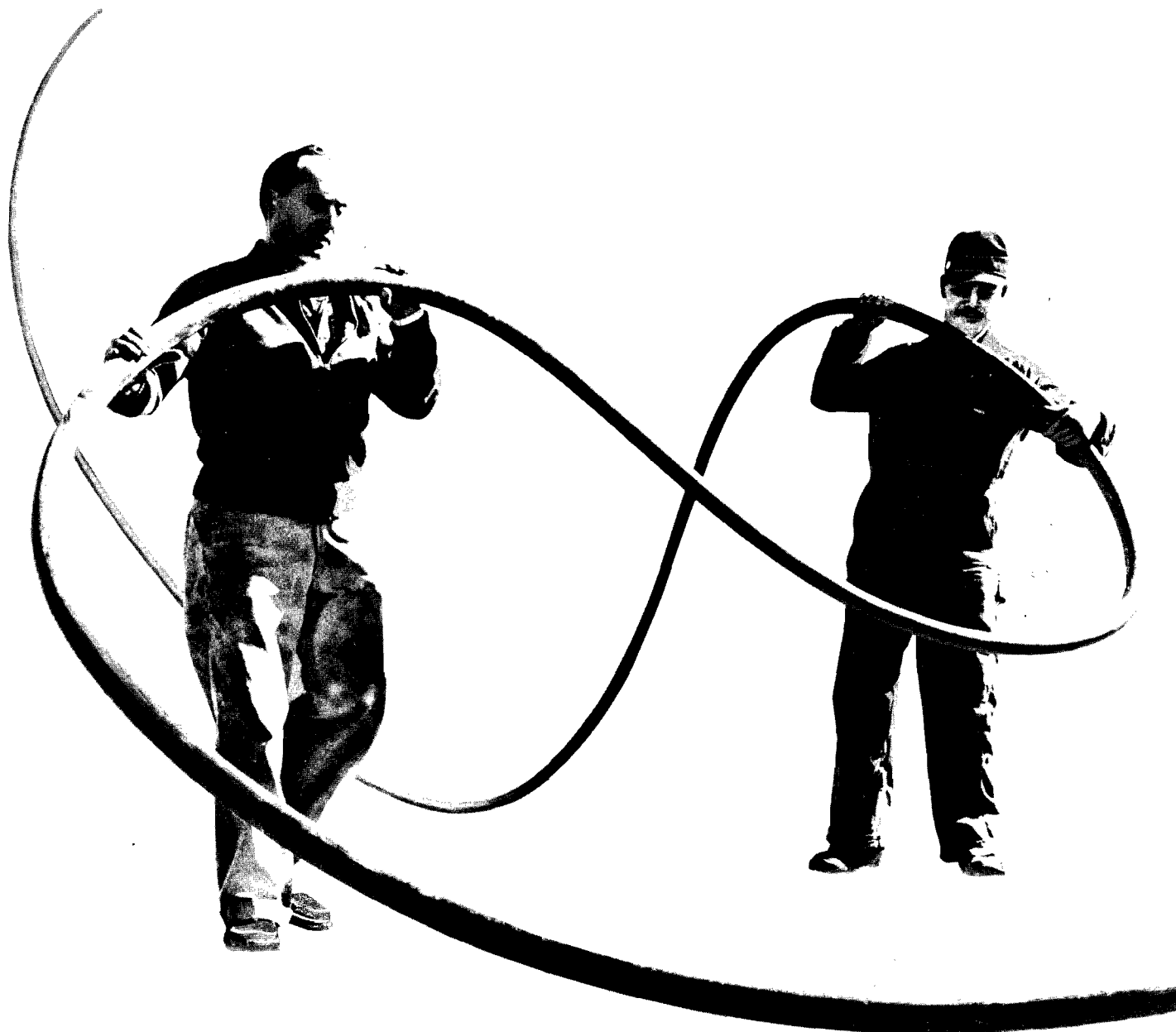


ARCHIVES

PLASTIC PIPE

A MANUFACTURING OPPORTUNITY IN GEORGIA



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P L A S T I C P I P E

A Manufacturing Opportunity in Georgia

Prepared for
The Georgia Department of Commerce
Scott Candler, Secretary

by

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Industrial Development Branch
Engineering Experiment Station
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Foreword

This is the first of a series of follow-up reports which will present more detailed information on specific products or product complexes included in the areas covered in our recent report on "Eight Potentials for Plastics in Georgia."

Like each of the reports to follow, this focuses on specifics regarding a particular item or items which can profitably be produced in Georgia. Since plastic pipe is a product which might be manufactured by a company entering the field for the first time as well as by an established firm interested in locating a branch plant, information which would be of concern to someone new to the field is included. Most of this material is contained in the last two sections, so that it can be easily by-passed by those familiar with the field.

The number of subsequent reports on plastic products, the speed with which they are completed, and the particular items to be evaluated will depend to a considerable extent on the amount of interest demonstrated by companies, individuals and local development groups. Comment and discussion are invited.

Kenneth C. Wagner, Head
Industrial Development Branch

Acknowledgments

The machinery manufacturers, material suppliers, extruders, and local distributors of plastic pipe were all exceedingly helpful in providing information and advice for this study. The local representative of the National Rubber Machinery Company, Mr. J. D. Robertson of Robertson & Company, contributed a great deal of his time, effort, and patience. The assistance of the other persons in the industry who gave so much of their time is gratefully acknowledged. The pictures were furnished by the United States Rubber Company and the Bakelite Company. The cover design was based upon a photograph provided by the Bakelite Company.

Special thanks to Mrs. Betty Jaffe for the typing of the several drafts and the final copy.

Summary

Over 10 per cent of the U. S. market for plastic pipe is located in the Southeast. Yet, the Southeast has only about two per cent of the pipe extrusion plants. There are none in Georgia.

Distributors of plastic pipe in this area have repeatedly voiced the need for pipe production in Georgia.

The technical characteristics of these pipes insure a wide and expanding future market. Only a start has been made in realizing the potentials available in plastic pipe applications.

Pipe makers forecast that plastic pipe sales will quadruple over the next eight years. Sales are expected to increase from \$45 million in 1957 to \$200 million in 1966.

The extrusion machine is very flexible. Hence, a producer can begin business with a product such as polyethylene pipe that has a wide market and later diversify his operations over a broad range of products.

These are the more important reasons why the production of plastic pipe in Georgia offers an opportunity either for establishment of a new business or for a branch facility of an existing pipe extruder.

There is a present southeastern market for plastic pipe of from seven to eight million dollars. And if the Southeast does no more than maintain its relative share of the total U. S. market, this amount can be expected to quadruple in less than 10 years.

Though over a dozen basic types of synthetic resins are used in pipe production today, three materials account for 93 to 95 per cent of all plastic pipe sales. These three, polyethylene, polyvinyl chloride (PVC), and acrylonitrile-butadiene-styrene (ABS) copolymers are analyzed in this report.

The present market is dominated by polyethylene--particularly scrap polyethylene. Rural applications are of major importance among the end uses for this pipe. This end use pattern is such that as the sales of this pipe increase the Southeast can expect an increasing share of the total market.

Pipe made from ABS has a relatively smaller market in the Southeast. In some cases it competes with polyethylene; in others it competes with PVC. The outstanding characteristics of ABS pipe and the cost advantages it enjoys are factors which point toward a fast growing market for this product. Sprinkler systems, jet well and other water lines are major uses for ABS in the Southeast.

PVC pipe is used principally in the chemical and chemical processing industries. The sales of this pipe trail both polyethylene and ABS pipe sales in the Southeast, as well as the U. S. as a whole. However, the various plastic pipes are not by any means perfect substitutes for each other. There are a multitude of applications where PVC pipe is finding rapidly expanding markets.

The extrusion process for these materials is basically a simple operation and the equipment required does not involve large capital investment. As a result, it is relatively easy to get into this business. On the other hand, ease of entry has its disadvantage in that competition is strong. However, the extruder can limit his effective competition by paying careful attention to quality. In fact, this is a necessity if he expects to continue to operate over the long run. It is expected that both distributors and consumers will, given time, become more aware of differences in pipe quality.

The extruder can widen his product line after establishing himself in the basic pipes discussed in this report. The processing industries in the South and Southeast will be a growing market for specialized pipes. Proximity to the processing plants is a necessity if proper service is to be provided. In addition to pipes, the versatility of plastics extruding machines allows the enterprising producer to make any of a wide variety of shapes for packaging, machinery, construction and other applications.

A producer would gain two principal advantages by locating in Georgia: (1) He could expect preferential treatment by southeastern distributors and consumers by virtue of having a local plant. (2) Transportation costs--a significant proportion of the sales price of polyethylene pipe--would be proportionally less, since Georgia is centrally located with respect to the southeastern market.

The fullest advantage of the many profit opportunities in plastics extrusion will be realized by the innovator in product design and marketing. Extrusion is a possibility which should be examined by prospective manufacturers and by firms in the State looking for diversification possibilities.

Alternately, the plastic pipe extruder presently located in one of the northern, eastern, or western states will also find the market analysis in this report of interest. The competitive conditions of the industry will continue to exert pressure for market-oriented plants. There are two principal reasons for this. First, it has been shown that transportation charges

are a significant portion of the extruder's sales price of scrap polyethylene --the largest volume material in pipe use. Second, proximity to the chemical and chemical processing industries developing in the Southeast will be an extremely important factor in capturing markets for the high-profit specialized pipes. Still a third consideration of interest to present pipe producers is the commanding position an experienced extruder would have in the development of production of other extruded products in the Southeast.

While a north Georgia site would offer certain advantages because of the pattern of the southeastern markets, a number of locations would be suitable. More specific sites will be recommended to interested firms or individuals, contingent on their specific requirements.

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I. INTRODUCTION

This study is an evaluation of the opportunities offered a plastic pipe manufacturer in Georgia. Its purpose is to provide present and prospective pipe extruders with a report on the various facets of plastic pipe production and marketing in Georgia.

The attention of the Industrial Development Branch was initially directed to plastic pipe during the course of its basic plastics industry study. When distributors of plastics products were asked for their suggestions as to what products might be profitably manufactured in Georgia, they almost invariably mentioned pipe. Further study revealed the phenomenal growth rate this product has experienced--and is expected to have in the future.

The first section of this report deals with the general nature of plastic pipe, the industry's growth, its market potential and present production pattern. Next, each of the three important plastics materials used in pipe are discussed, and their individual characteristics and markets are evaluated. The marketing section draws together the market information developed in section three. In addition, several important aspects of the extruder's marketing function are highlighted. The significance of transportation costs is analyzed in section five.

The last two sections of the report present information intended for firms or persons without experience in the plastics field. Present producers of pipe will therefore not need to read the entire report to find the information they are seeking.

Section six gives the reader an introduction to the equipment involved in plastic pipe extrusion. Other considerations pertinent to pipe production are also treated.

The section titled "Operations" presents estimated balance sheet and income statement data and provides other information relative to getting into business and developing the enterprise. Finally, the appendix lists machinery manufacturers and material suppliers. These firms are excellent sources for further information. The Industrial Development Branch is also prepared to work with firms or individuals seeking further information.

II. THE PRODUCT AND THE INDUSTRY

Plastic pipe can be generally characterized as lightweight pipe with superior resistance to rust, corrosion, chemical attack, and electrolytic action. It has excellent abrasion resistance and electrical insulation properties. Depending upon materials used and formulation techniques, plastic pipe may range from rigid to a high degree of flexibility. Its properties are so diverse that it is necessary to consider each type as an individual pipe. Users must evaluate each in terms of the particular application involved. In general, however, it can be said that the use of the plastic pipe presently available is restricted to applications where heat and pressure requirements are not high.

Plastic piping must, of course, compete with a wide variety of other pipe materials, both metallic and non-metallic. Its advantages cost-wise are the principal reasons for the dramatic growth it has experienced in recent years. Since the costs of synthetic resins have shown a downward trend while the costs of other materials and labor continue to climb, the cost differential in favor of plastic pipe will become increasingly important.

Comparisons of material costs between plastics and other pipe materials are only one aspect of the total cost picture. By themselves such figures have little significance. The cost of any pipe installation is dependent upon a combination of material, installation and maintenance costs, including service life. As a rough measure of comparison, however, the following gives some representative cost figures:^{1/}

| | <u>COST/FT.--SCHEDULE 40</u> | |
|--------------------|-------------------------------------|--------------------------------------|
| | <u>$\frac{1}{2}$ in.</u> | <u>$1\frac{1}{2}$ in.</u> |
| Carbon steel | \$0.10 | \$0.29 |
| Galvanized iron | 0.12 | 0.36 |
| Polyethylene | 0.14 | 0.41 |
| Wrought iron | 0.21 | 0.59 |
| Aluminum | 0.24 | 0.70 |
| PVC | 0.28 | 0.75 |
| Red brass | 0.64 | 1.87 |
| Lead -- AA | 0.75 | 2.25 |
| Stainless Type 304 | 1.52 | 3.89 |
| Monel | 1.72 | 4.68 |
| Stainless Type 316 | 1.96 | 5.28 |

^{1/} Based on: J. P. Kelleher and C. L. Mantell, "Process Piping--Plastics Vie with Metals," Chemical Engineering, Vol. 64, November 1957, p. 304.

Size for size comparisons are actually quite inadequate when evaluating pipes. One important factor which makes these comparisons inadequate is the smooth interior walls which are characteristic of plastic pipes. This smoothness results in a low coefficient of friction and minimum impedance to flow. A comparative chart published by Franklin Plastics, Incorporated, shows that 1½ inch schedule 40 steel pipe has a head loss almost exactly equal to that of Franklin's 1½ inch schedule 40 "Dur-X" polyethylene pipe, for example.

Plastic pipe's light weight and ease of assembly facilitates handling and joining, with resultant reductions in the labor cost of installation. Installation cost for plastic piping is generally lower than for metal. "In the case of threaded installations, the installation cost ratio, steel to plastic, runs from 2:1 to 3.5:1 or higher. In solvent cemented installations it runs from 3:1 to 8:1. In outdoor installations where the pipe is laid in a trench, the ratios go much higher--to 8:1 for threaded lines and 18:1 for solvent cemented. The recently introduced PVC drainage lines show a ratio, compared to conventional leaded bell and spigot jointed lines, of at least 1:8.^{1/}

High chemical and corrosion resistance gives plastic pipe a long service life. (See Table 1.) Replacement cost is reduced and routine maintenance expenditures are held to a minimum. Over-all, then, the reasonable material cost and low installation and maintenance cost combine to make plastic pipe the least-cost product for a multitude of applications.

^{1/} H. G. Davis and E. A. Erick, "Plastic Piping: Installation, Use, and Comparative Costs," Tappi, Vol. 41, June 1958, p. 88 A.

Table 1

CHEMICAL RESISTANCE OF VARIOUS PIPE MATERIALS

| | Polyethylene | Polystyrene copolymer | Polyvinyl chloride | Carbon steel | Stainless steel (18-8) | Cast iron | Copper | Brass |
|---------------------------|--------------|--------------------------|-----------------------|--------------|---------------------------|-----------|--------|-------|
| Salt solution | G | G | G | U | G | G | G | F |
| Soaps and detergents | G | G | G | G | G | G | F | F |
| Alkali | G | G | G | F | G | G | F | F |
| Dilute acid | G | G | G | F | F | F | F | F |
| Sulphates | G | G | G | F | G | G | G | G |
| Bleach solutions | G | G | G | U | G | U | F | F |
| Animal and vegetable oils | F | G | G | F | G | G | G | G |
| Caustic solutions | G | G | G | F | G | G | F | F |
| Gasoline and fuel oils | U | F | G | G | G | G | G | G |
| Alcohol and glycol | U | F | G | G | G | G | G | G |
| Strong acids | G | F | F | U | F | F | U | U |
| Organic solvents | U | U | U | G | G | G | F | F |
| Esters and ketones | U | U | U | G | G | G | G | G |

G: Good

F: Fair

U: Unsatisfactory

SOURCE: "Pipelines to the Future: A Study of Plastic Pipe," Monsanto Chemical Company, Plastics Division, Springfield, Massachusetts, 1955.

A. Production

A survey of the industry has revealed that there are more than 180 producers of plastic pipe. It is reported that there are nearly 100 extruders of polyethylene pipe alone. This large number of pipe producers includes a great many small, marginal operators supplying localized markets. Therefore, the number of important producers is much smaller. The pattern of production is complicated by the fact that the manufacturers have differing product mixes. Some make only polyethylene. Some produce polyethylene, ABS and PVC. Others make PVC and butyrate. And so on.

Of the firms that have been identified as producers of plastic pipe over 60 per cent were found in Thomas' Register. If those not listed are assumed to have capitalizations of \$100,000 or less, the following pattern of capitalization for firms engaged in plastic pipe production emerges:

| <u>Capitalization</u> | <u>Per Cent</u> |
|-----------------------|-----------------|
| over \$1,000,000 | 26 |
| over 500,000 | 8 |
| over 300,000 | 7 |
| over 100,000 | 14 |
| \$100,000 or less | 45 |

It can be seen that the median capitalization figure is slightly in excess of \$100,000. The large number of firms with capitalizations of over \$1 million reflects the fact that plastic pipe is being produced as a minor product by some very large corporations, including American Hard Rubber Company, Crane Company, B. F. Goodrich, Minnesota Mining and Manufacturing Company, U. S. Steel, Republic Steel, U. S. Rubber, and Wheeling Steel. The reported leading manufacturer of plastic pipe is Carlon Products Corporation, which specializes in this particular product. This company's capitalization is estimated at over \$1 million.

The companies presently producing plastic pipe can be roughly divided into three groups:

(1) The companies, such as the steel and rubber producers, that make competitive products. They have entered the field because of the competition that plastics have given conventional pipe materials and because their present distribution facilities are ready-made outlets for the product.

(2) Extruders and other plastics processors who have seen the opportunities available in plastic pipe and have expanded their product lines to include this class of items.

(3) Firms who have initially entered the plastics field by producing plastic pipe.

Production facilities are concentrated in the Middle Atlantic states, East North Central states, Texas and California. (See Map 1.) Only five plants have been found to be located in the Southeast.^{1/} Of these, only one is believed to have any significant pipe output. This is a branch facility of one of the larger producers. There are no pipe extrusion plants in Georgia.

B. Markets

Accurate figures for plastic pipe sales are not available. Estimates are found to differ widely, due principally to the variety of materials employed, the large number of producers, and the rapid expansion of the industry. Chemical Week, August 9, 1958,^{2/} reported, on the basis of a poll of plastic pipe makers, that estimated resin consumption for pipe in 1958, will be 56 million pounds. In dollar figures, 1957 sales at the manufacturers-distributors level were estimated to be \$45 million. The pipe manufacturers predict this figure will climb to \$70 million per year by 1960, and to \$200 million per year by 1966. (See Chart 1.) These estimates are not at all unrealistic, since large untapped markets exist. As pipe users become aware of the properties and advantages offered by plastics, markets will continue to open up.

William Abramowitz, president of Carlon Products Corporation, says the biggest problem facing plastic pipe producers is the presence of obsolete, restrictive codes.^{3/} Codes are difficult to change because of resistance by metal pipe manufacturers, unions and apathetic public officials. The inherent characteristics of plastic pipe, however, are such that these difficulties will be overcome with time and effort on the part of the plastic pipe industry. And each obstacle that is pushed aside will open the way to more and larger markets.

^{1/} For purposes of this report the "Southeast" is defined as the six-state area: Alabama, Tennessee, North Carolina, South Carolina, Georgia and Florida.

^{2/} "Markets for Plastic Pipe: Progress with Problems," p. 77.

^{3/} "For Plastic Pipe: Progress with Problems," Chemical Week, August 9, 1958, p. 77.

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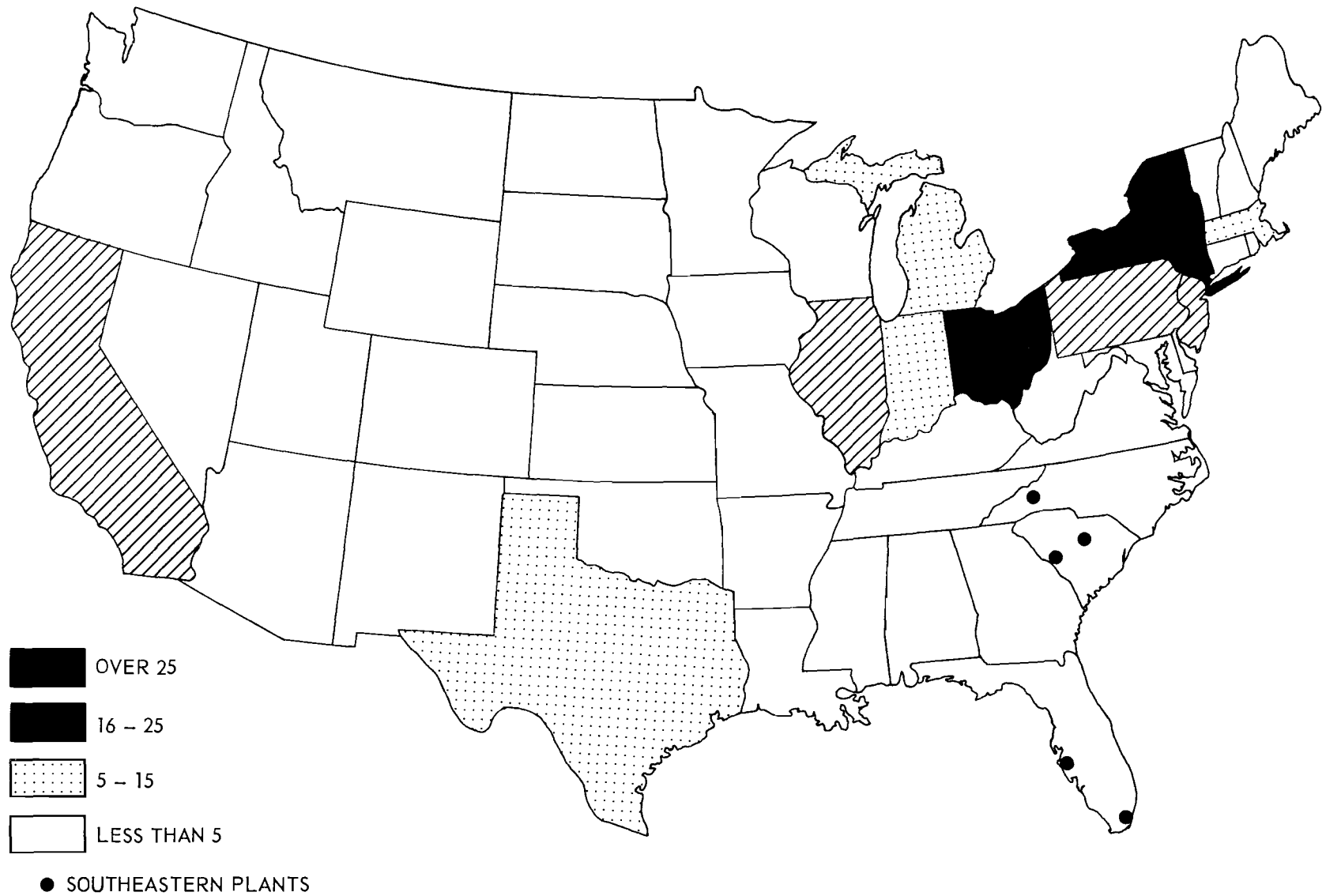
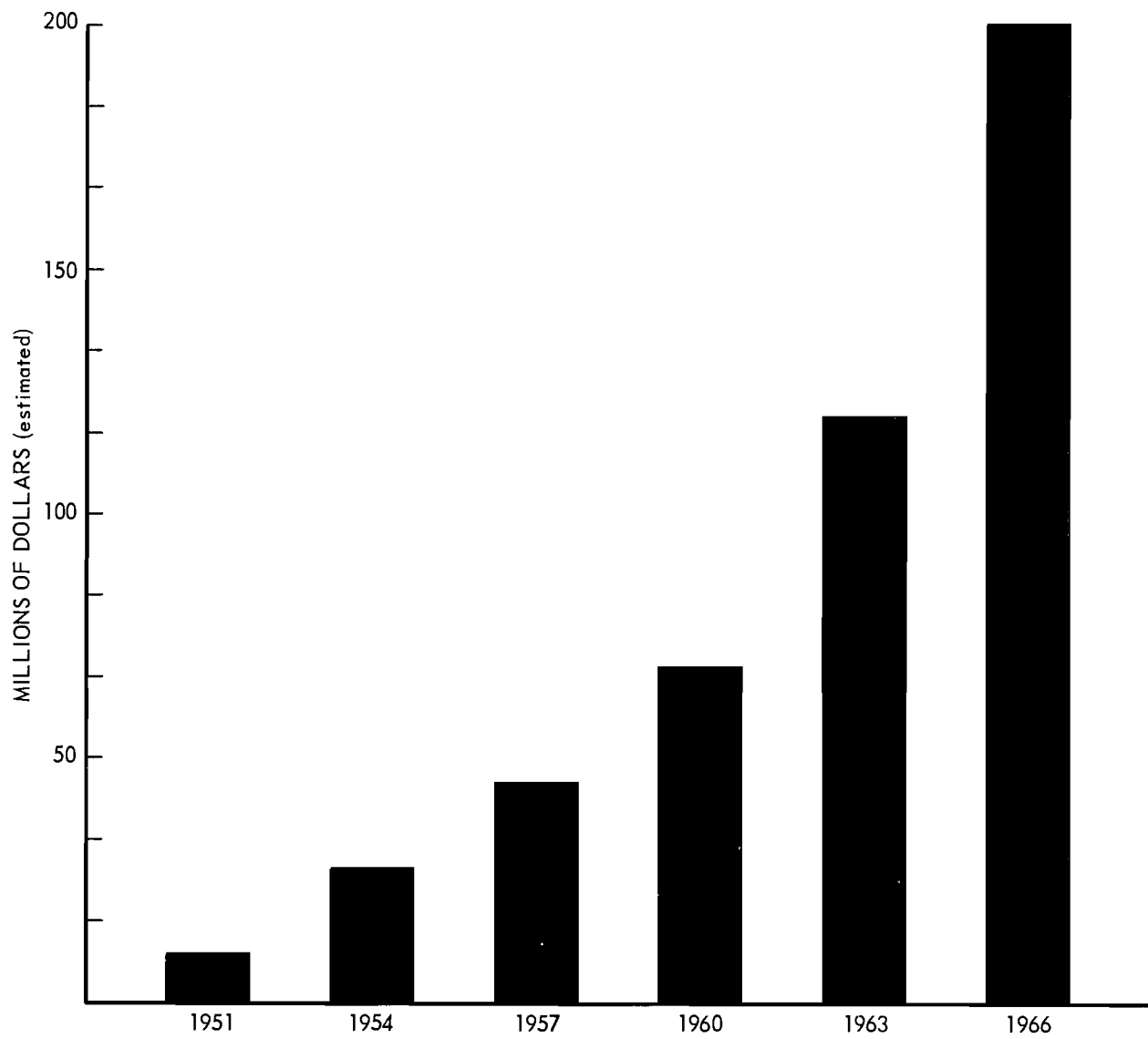


CHART 1: U.S. PLASTIC PIPE MAKERS' FORECAST



SOURCE: *CHEMICAL WEEK*, VOL. 83, (August 9, 1958), p.77.

C. Materials

The various types of plastic pipe are classified by the materials used in their manufacture. These materials are synthetic resins. The individual resins impart widely differing characteristics to the pipe product. The following table includes all resins used to any significant degree in plastic pipe production today. (Percentages indicate estimated share of total U. S. plastic pipe market.)

| <u>Resin</u> | <u>Per Cent</u> |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|
| Polyethylene | 67 |
| ABS (Acrylonitrile-butadiene-styrene copolymers) | 16-20 |
| PVC (Polyvinyl chloride) | 10 |
| Butyrate (Cellulose acetate butyrate) | 2 |
| Miscellaneous | 4-6 |
| Chlorinated polyether; epoxy; methyl methacrylate; nylon; phenolic asbestos; polyester; polyfluorocarbons; polypropylene; reinforced plastics; saran (vinylidene chloride) | |

A glance at the percentage figures given above will show that only three of these resins are presently important in plastic pipe production. Butyrate's proportion of the market has been declining over the past few years. And the remainder of the pipe materials must share about five per cent of the market. Since polyethylene, ABS and PVC account for 93 to 95 per cent of all plastic pipe sales, this report will be devoted primarily to these three materials.

The other synthetic resins have individual characteristics which limit their uses. Butyrate has only a narrow range of chemical resistance and tends toward brittleness. Price is the most important restriction of those materials listed under the "Miscellaneous" classification. But production techniques are frequently more complicated and technical requirements more exacting, as well. The result is a number of specialized pipes, produced in small volume by a limited number of manufacturers.

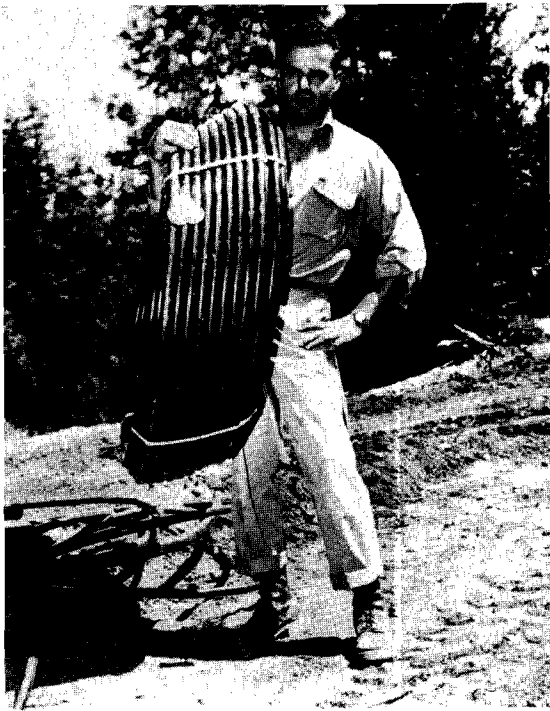


Fig. 1. The characteristics of polyethylene pipe contribute to ease of handling, laying, cutting, and joining.

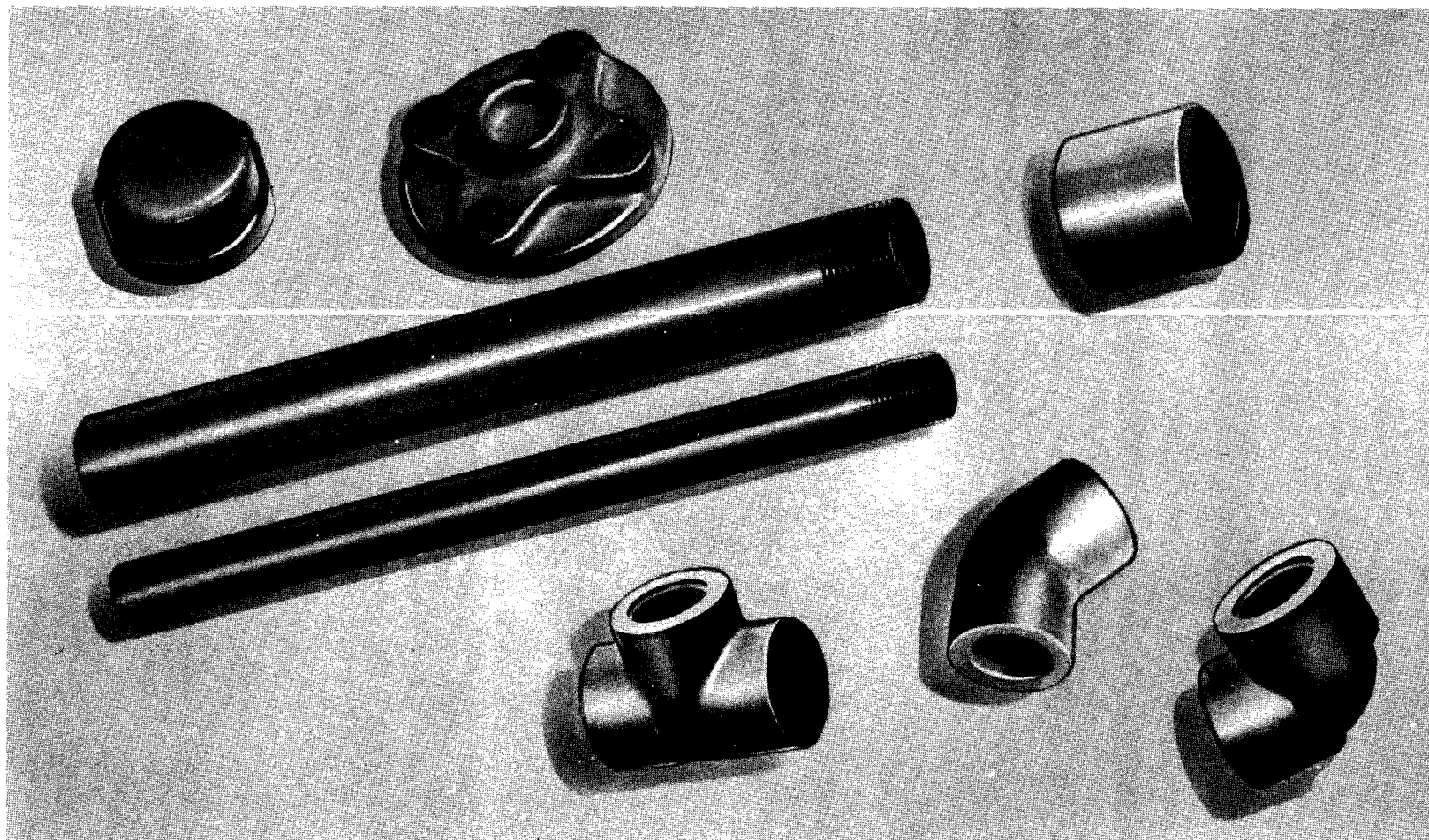


Fig. 2. Plastic pipe may be threaded and joined with a complete range of plastic fittings.

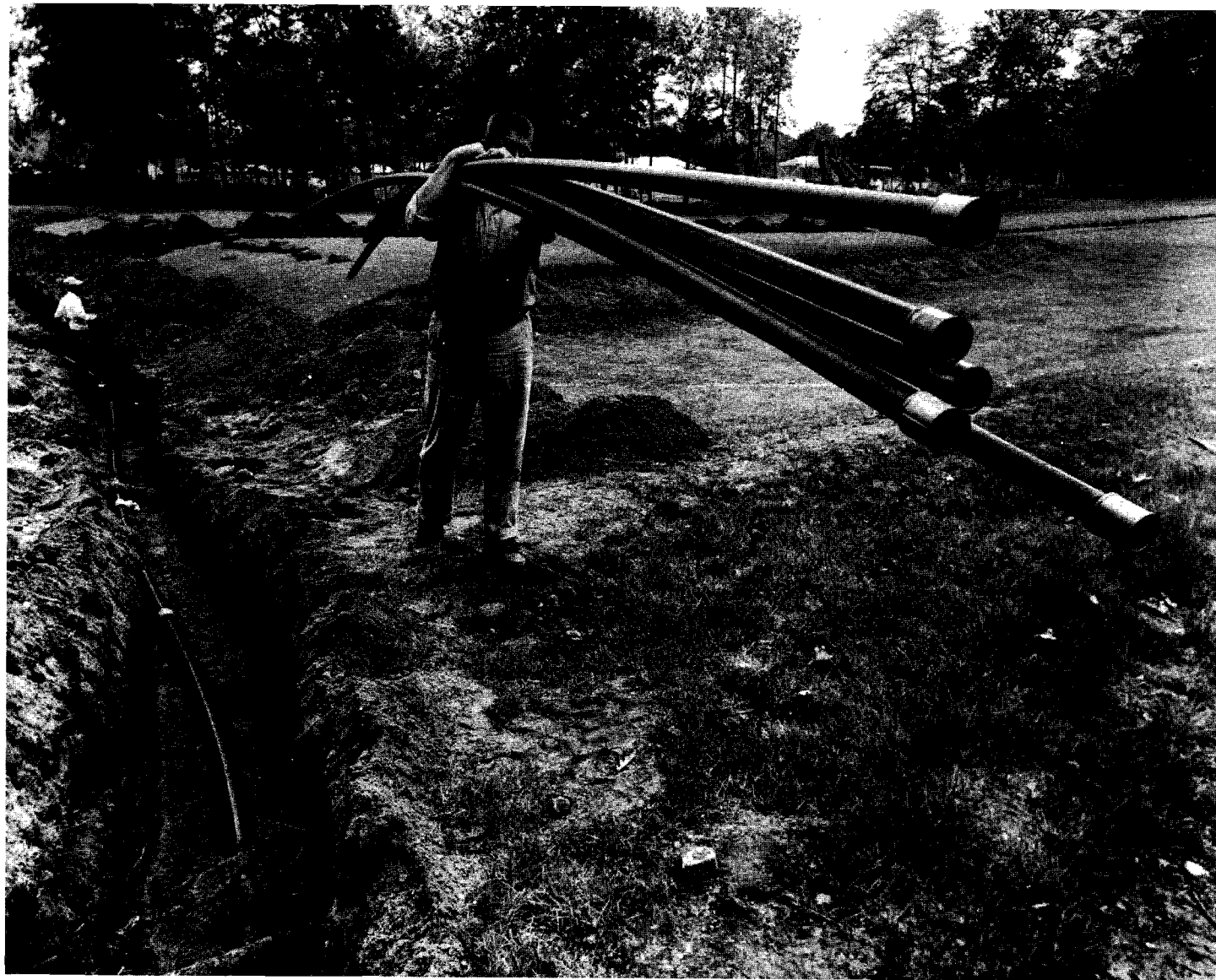


Fig. 3. Rigid plastic pipe is lightweight and may be laid more easily than other rigid pipes.

III. TYPES AND MARKETS

A. Polyethylene Pipe

Polyethylene was the first resin to find a volume pipe market in the U. S. As recently as 1954, when some 18 million pounds of polyethylene was being processed for pipe, there was no other plastic material that had a pipe market of over one million pounds. Today polyethylene still maintains its dominant position, holding about 70 per cent of the total plastic pipe market.

Characteristics

Principal among the advantages offered by polyethylene pipe is its flexibility. It can be laid in a rough trench or on the surface of the ground. The problems inherent in straight rigid lengths of pipe are avoided. Secondly, the smaller sizes are sold in coils which are readily available in lengths up to 400 feet and may be purchased in longer lengths. Therefore, the pipe can be laid continuously with a minimum of joints. In fact, a conventional tractor with attachments can be used in a continuous trenching, laying and filling operation.

These factors of flexibility and continuous length, combined with the light weight of polyethylene, result in drastically reduced installation cost. (Polyethylene is the lightest of the principal pipe materials. A 400-foot roll of 3/4 inch polyethylene pipe weighs only 52 pounds. A comparable length of conventional pipe would weigh at least 10 times as much.) This is a primary sales point for polyethylene pipe.

Installation is further facilitated by the fact that no special tools are required. Polyethylene pipe can be cut by an ordinary pocket knife; sections are joined by the use of insert fittings and band clamps. Some fittings problems have been encountered, but are presently believed to be under control. Certain problems inherent in the very nature of insert fittings cannot be avoided, however. Such fittings cause restrictions of more narrow diameter than the pipe itself, which results in a larger diameter pipe being required than would be necessary if other joining methods were feasible. In any event, the smooth interior of this pipe more than offsets the disadvantage of insert fittings.

Polyethylene has the highest impact strength and the highest dielectric strength of the three materials discussed in this report. Its tensile strength is the lowest. Its maximum operating temperature, 120 degrees F., is also the lowest. It has a low pressure range and is quite susceptible to creep. Due to its flexibility, polyethylene pipe must be continuously supported. This is an obvious disadvantage in some applications.

Hot water reduces the strength of the pipe drastically. Therefore, when there is danger of hot water backing into a polyethylene pipe, check valves must be installed. Another disadvantage of polyethylene pipe is that such pipe is easily cut or penetrated. In home use, there is the possibility that carpenters or the homeowner may puncture the pipe. Polyethylene pipe is subject to attack by ultra violet light also. This can be offset, however, by the addition of two or three per cent carbon black in the extrusion formulation.

Quality

Quality poses one of the greatest problems facing polyethylene pipe producers today. Though pipe extrusion at first glance appears to be a very simple process, the continuing production of a uniformly high quality product is a technical problem of some proportion. The apparent simplicity of the process and the comparatively low investment cost required to go into the manufacture of this product have resulted in large numbers of small operators entering the field. As a consequence, large quantities of low grade pipe have been produced. This situation not only has a detrimental effect on profit margins, but it poses an even more basic threat to the well-being of the entire plastic pipe industry. However, several members of the industry are attempting to set up and maintain industry standards for plastic pipe.

Markets

Estimates of the amount of polyethylene resin presently going into pipe vary by approximately 10 per cent. In this report the figure published by James E. Sayre in Modern Plastics, July 1958,^{1/} has been used. A leading market researcher and chemical economist, Mr. Sayre places the 1957 U. S. combined consumption of scrap and virgin polyethylene resin in pipe at 45 million pounds. This volume is estimated to represent total sales at retail of about \$35 million.

^{1/} "Markets for Polyethylene Pipe," p. 100.

The major uses for polyethylene pipe are in the transmission of water. Pipe containing 100 per cent virgin materials has been approved by the National Sanitation Foundation for the transmission of drinking water.^{1/} At present, however, some 50 per cent of the polyethylene pipe sold in the U. S. contains scrap material. The percentage in the Southeast is much higher.

Though conventional polyethylene is not suitable for hot water lines, the potentials available for this pipe in cold water uses have as yet not been realized to any significant degree. While some gains have been made in the use of polyethylene pipe for home water supply in rural areas, building codes have greatly restricted urban market development. A major breakthrough was recently made, however, when the city of Cleveland, Ohio approved the use of flexible plastic pipe for connecting water mains to homes within the city limits.

Mr. Sayre estimates polyethylene pipe consumption by end use as follows:

| <u>End Use</u> | Pounds (millions) <u>1957</u> |
|---------------------------------------|-------------------------------------|
| Farm water lines | 8 |
| Lawn watering piping | 6 |
| Irrigation and subirrigation lines | 3 |
| Jet well lines | 7 |
| Household piping | 8 |
| Corrosion and petroleum piping | 3 |
| Swimming pool and skating rink piping | 3 |
| Mine piping | 2 |
| Other uses | <u>5</u> |
| Total | 45 |

^{1/} This does not mean that only virgin pipe is used for conveying drinking water. Users frequently buy pipe containing scrap material for use in the transmission of drinking water--particularly in the Southeast. Some do this because of inadequate or misleading information. Others buy scrap pipe for price considerations with full knowledge of the disadvantages. It is estimated that only about 10 per cent of the polyethylene pipe sold in the rural markets of the Southeast is of pure virgin material.

The importance of the rural market in polyethylene end uses is readily apparent. It is evident that the southeastern market for this pipe is quite significant. Farm water lines, irrigation, jet well lines, and household piping represent almost 60 per cent of the total consumption of polyethylene pipe.

Weighting the figures above by measures of the relative importance of each end use by geographic divisions provides a means of estimating the polyethylene pipe market in the various sections of the U. S. The results of applying this technique are shown on Map 2.

These percentages result in the following retail market estimates for the South and the Southeast:

| | <u>Pounds</u> <u>(millions)</u> | <u>Dollars</u> <u>(millions)</u> |
|-------------------------------------|------------------------------------|-------------------------------------|
| South Atlantic & East South Central | 10 | 8 |
| Southeast | 6 | 5 |

The five million dollar market estimate above was verified by a survey of major distributors in Georgia. The distributors were asked for their annual sales of polyethylene pipe and for an estimate of their market share. The total market estimate obtained from an extension of these reports was slightly in excess of five million dollars.

B. PVC Pipe

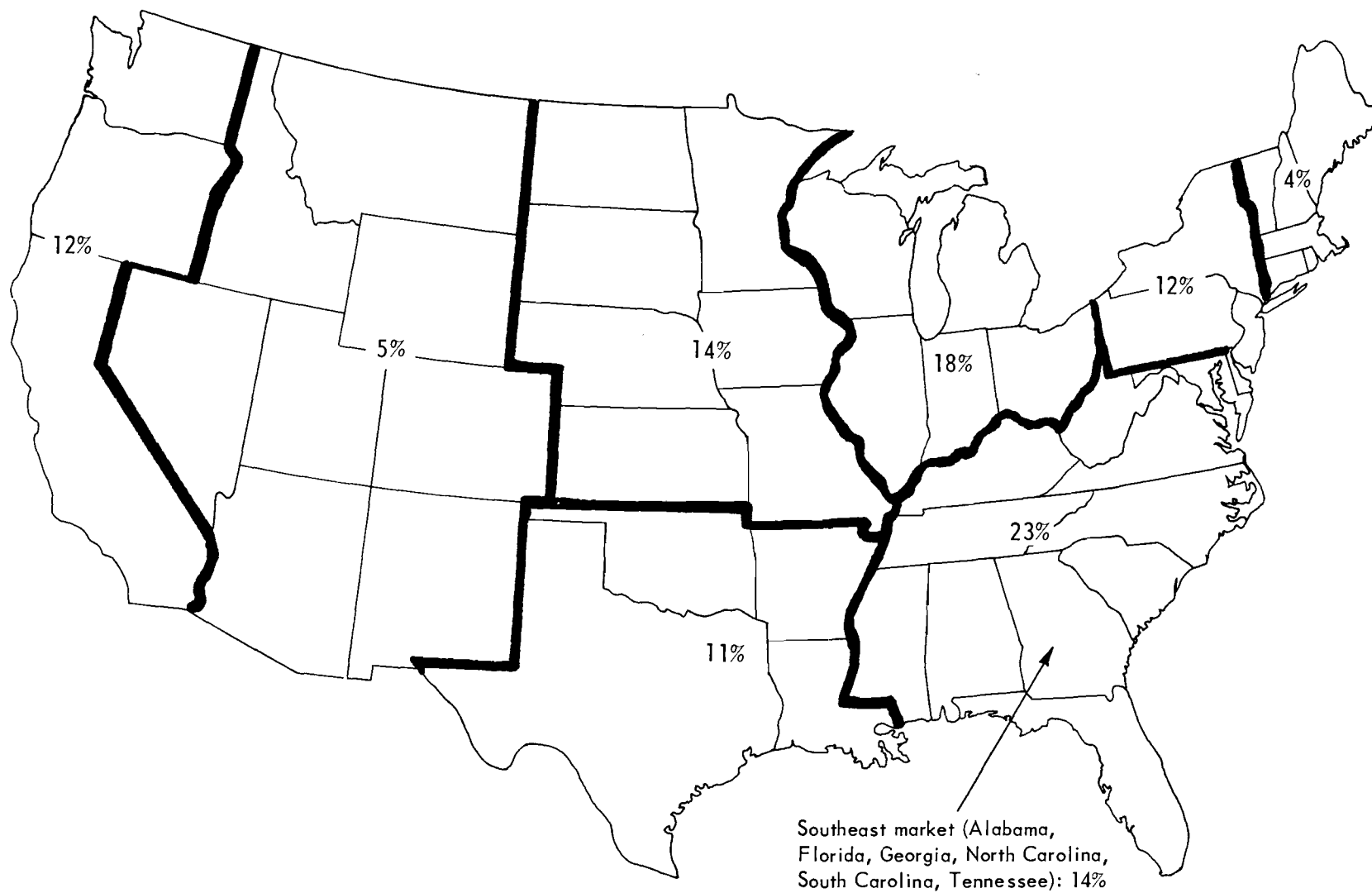
A comparison of polyvinyl chloride and polyethylene brings out strikingly the fact that plastic pipe cannot be considered as a homogeneous group. The technical differences are such that the end uses vary considerably. PVC exhibits much higher chemical resistance, higher temperature resistance and is more expensive than polyethylene.

The principal uses for polyethylene involve water transmission. PVC is also used for conveying water, but only where polyethylene or ABS is not suitable. Chemical and chemical processing applications consume most of the PVC pipe output. PVC does not, therefore, compete extensively with polyethylene for pipe markets. Its strongest competitor is the ABS type material.

Characteristics

Polyvinyl chloride pipe is rigid and has good creep resistance and good dimensional stability. It has the highest tensile strength among thermoplastic

MAP 2: POLYETHYLENE PIPE MARKET ESTIMATE - 1958
(Per Cent of U.S.)



pipes. It has a maximum operating temperature of from 130 to 150⁰ F. At the other end of the temperature scale, however, PVC is found to be brittle at freezing temperatures. It is 50 per cent heavier than polyethylene.

Four joining methods are available for connecting lengths of PVC pipe. The solvent-cemented joint is the most popular and fastest technique. The cement is brushed on to the pipe ends and the sleeve-type fitting. The ends are then butted together inside the fitting and given a one-quarter turn. After a few minutes, the joint is bonded. Schedule 80 and schedule 120 pipe can be threaded. The tools and techniques are the same as those used for threading of other non-ferrous materials.

The third joining method is unique with PVC pipe. By using the technique of hot air fusion, PVC pipe can be heat welded in the field. The heat weld has an average tensile strength of approximately 90 per cent of the original material. A fourth and last method of installing PVC involves the use of an adhesive. The adhesive, a synthetic resin, is used to attach the pipe fittings.

Of these four methods, the solvent-cemented joint is the most satisfactory for the majority of installations. It is not only the fastest and easiest method, but also gives the highest joint strength.

Both unplasticized (Type I) and plasticized (Type II) PVC pipe is being marketed. Type I has very low impact strength. The use of a plasticizer in Type II pipe improves this characteristic considerably, but at the sacrifice of some corrosion resistance. Types I and II differ in most characteristics and must be selected on the basis of the particular application. Their prices are identical. Both types are normally available in 10 and 20 foot lengths.

Markets

Estimates of PVC pipe production in 1958 indicate that this type of pipe is consuming between four and five million pounds of resin. This figure is only 10 per cent of that for polyethylene resin consumption in pipe. The dollar value of PVC sales would be a higher percentage, however.

No information has been found as to the geographical consumption pattern of PVC pipe. Nor is there information available that gives end-use distribution for this product. However, the list below is believed to include the principal applications of PVC pipe:

chemical plant piping;
food processing piping;
paper and textile plant piping;
refinery and oil field piping;
risers;
salt water piping;
shipboard piping and washdown system lines;
water lines.

The predominant uses for PVC pipe--an estimated 85 per cent--are in the chemical and chemical processing industries. If, on the basis of this fact, PVC pipe consumption is assumed to be geographically distributed in the same locational pattern as these industries, a measure may be obtained of the southeastern market. The application of this technique gives an estimated southeastern market of between \$500,000 and \$1,000,000 at the end use level.

The markets for PVC pipe are considerably more limited than are those for polyethylene and ABS pipes. It is the most expensive of the three and can be processed only as a rigid shape. Its superior chemical resistance is its principal advantage.

PVC pipe will enjoy an expanding market as a result of (1) the rapid rate of expansion expected in the chemical and allied industries, and (2) a vast market presently available that has not been fully tapped as yet.

C. ABS Pipe

"ABS" is the gratifying abbreviation for the acrylonitrile-butadiene-styrene copolymer blends. It is a styrene-rubber formulation. This material is produced in such volume by Naugatuck Chemical Division of U. S. Rubber that Naugatuck's trade name, "Kralastic," has almost become a synonym for the basic material. "Cycolac," a product of Marbon Chemical Division, Borg-Warner Corporation, is another ABS material.

Pipe made from ABS has been among the fastest growing of the plastic pipes. While the market share of polyethylene has dropped somewhat since 1954, ABS materials have increased their share of the plastic pipe market from about six per cent to about 18 per cent in the same period. 1958 sales of ABS in pipe have been estimated by pipe makers at seven million pounds.

The characteristics of ABS pipe are such that its end uses are "in-between" those of polyethylene and PVC. ABS is the intermediate step between the other two more contrasting materials. As such it competes in both markets.

Characteristics

ABS pipe is produced in either rigid or semi-rigid form. The National Sanitation Foundation has approved this material for the transmission of drinking water.

ABS has outstanding impact strength, high tensile strength, good dimensional stability, good chemical resistance, and is impervious to electrolytic action. It is the lightest of the rigid pipes (one-seventh the weight of steel) and has the highest temperature resistance of the plastics in broad use for pipe. Conventional ABS has a maximum operating temperature of around 165° F. and Naugatuck's new formulation, Kralastic HTHT, has raised this figure to 180°. In comparison, polyethylene is not generally recommended for uses where temperature requirements exceed 120°. ABS also has the highest pressure resistance of the leading pipe materials.

The methods of joining ABS pipe are the same as those used for joining PVC pipe, with the exception that ABS cannot be heat welded. The user may join ABS pipe by using solvent cement, adhesives, or by threading (schedule 80 and larger). It is typically sold in 20 foot lengths.

Markets

The principal uses in the U. S. for ABS pipe include natural gas transmission, oil field applications in transporting salt water and crude oil, jet well lines, sprinkler systems, water lines, and chemical and chemical processing industry applications. George R. Vila, vice president and general manager of Naugatuck Chemical Division, reported in 1957^{1/} that from a mileage standpoint the biggest use for Kralastic pipe is in transporting natural gas. From the standpoint of poundage, more of the material is used in oil field piping.

The "in-between" market status of ABS pipe in relation to polyethylene and PVC can be seen in an analysis of uses. Many of the producers of the other pipes manufacture ABS pipe as a complementary product. It serves this purpose well since it has available a broad and diverse market. No firms have been identified that produce only ABS pipe.

The largest volume uses over the country as a whole are not as important in the Southeast. Yet there are substantial markets in this area. The five applications listed below probably consume about 90 per cent of the ABS pipe shipped into the Southeast:

^{1/} "6000 Miles of Pipe," Modern Plastics, Vol. 34, July 1957, p. 100.

golf course and other sprinkler systems;
water lines and mains for small distribution systems;
jet well lines;
industrial piping;
home and farm water lines.

The order of listing here has some rough significance, though no attempt has been made to make a detailed market analysis. These uses have been determined by communication with local representatives and distributors.

The total southeastern market for all ABS pipe uses is estimated to be between one and two million dollars. This figure was arrived at by analysis of end-use patterns and verified by using distributors' and representatives' estimates. On a footage basis, ABS apparently outsells PVC in this geographical area by two or three to one. From the standpoint of expected growth, ABS is perhaps the most promising of the three materials discussed in this report.

IV. THE MARKETING OF PLASTIC PIPE

The plastic pipe manufacturer faces keen competition. The marketing of plastic pipe is therefore of special importance to anyone considering entering the field in the Southeast. A local producer would have advantages in transportation costs and in other factors growing out of his proximity to the market. But he should expect to support a vigorous sales effort in order to fully exploit these locational advantages.

In the previous sections it was pointed out that ABS pipe sales exceed the sales of PVC in the Southeast as well as in the U. S. as a whole. While precise figures are not available, the reverse is believed to be true in Florida. It is certain that Florida has a much higher percentage of PVC sales than does the rest of the six-state area. This is due to the energetic efforts of one PVC pipe representative in Florida. The lesson is obvious. There is a substantial, young and growing market in the Southeast. The dynamic marketing innovator can hope to capture a major portion of this market for his firm.

In this section pertinent aspects of the marketing function of an extruder are discussed. These points are needed to provide the prospective producer with a more comprehensive view of the business.

Market Summary

As noted in the preceding section, the present plastic pipe market is dominated by polyethylene--scrap polyethylene particularly. The principal end uses for pipe made from this basic material are non-industrial. Rural applications are of particular importance. This end use pattern is such that as the sales of this pipe increase the Southeast can expect an even larger share of the total market.

Pipe made from ABS materials has a relatively smaller market in the Southeast. Its uses are intermediate. In some cases it competes with polyethylene; in others it competes with PVC. The outstanding characteristics of ABS pipe and the cost advantages it enjoys are factors which point toward a fast growing market for this product. Sprinkler systems, jet well and other water lines are major uses for ABS in the Southeast.

PVC markets are more limited here. They are found principally in the chemical and chemical processing industries. The sales of this type pipe trail both polyethylene and ABS pipe sales in the Southeast as well as in the U. S. as a

whole. The various plastic pipes, though, are not by any means perfect substitutes for one another. There is a multitude of applications where PVC pipe is finding rapidly expanding markets.

There is a present southeastern market for plastic pipe of from seven to eight million dollars. And if the Southeast does no more than maintain its relative share of the total U. S. market, this amount can be expected to quadruple in less than 10 years.

Distribution Channels

The distribution channels followed by polyethylene pipe from the producer to the consumer are quite varied, due to its multitude of end-use applications. The predominance of the rural market is reflected in the importance of farm co-operatives, farm supply wholesalers, well and pump contractors, mail order and hardware wholesalers in the distribution of this material. The producer contacts these middlemen either through his own salesmen or through manufacturers' representatives. The table following shows the channels of distribution over the U. S. for polyethylene pipe, in approximate order of volume handled.^{1/}

Wholesalers

Independents
Farm Co-ops
Farm supply
Metal pipe
Building materials
Plumbing and heating
Pipe and supply
Hardware
Industrial and mill supply
Well and pump contractors
Mine supply
Heating and air conditioning
Greenhouse suppliers
Mail order houses

Retailers

Independents
General
Farm supply
Metal pipe
Building materials
Plumbing and heating
Hardware
Mail order houses
Industrial accounts
Well and pump contractors
Swimming pool contractors

^{1/} James E. Sayre, "Markets for Polyethylene Pipe," Modern Plastics, Vol. 35, July 1958, p. 100.

PVC pipe does not have so varied a distribution pattern. Since its major markets are industrial, it is distributed primarily through industrial jobbers, heating and air conditioning jobbers, plumbing and heating jobbers, and through direct sales efforts by company salesmen and representatives. PVC pipe requires specialized marketing procedures, since it is typically sold on its engineering characteristics.

Here again ABS is the middle-ground material. Its applications in large sprinkler installations and in industrial plants require individual sales effort. Industrial jobbers are frequently used. On the other hand, ABS pipe also follows the same channels as does polyethylene, since it is generally offered as a complementary product along with polyethylene pipe--principally for use in jet well lines.

A 1955 study of Monsanto Chemical Company can be used to provide some insight into the cost of plastic pipe distribution. Monsanto puts the jobber's discount at 18 per cent of retail and the retailer's discount at 28 per cent of retail. This gives a total distribution cost of 46 per cent of final selling price. Therefore, the pipe producer sells his product at some 54 per cent of the retail price.

Product Differentiation

Product differentiation is most effectively accomplished when a firm's product can be distinguished physically from that of its competitors. This is virtually impossible to accomplish with plastic pipe. Western Plastics Corporation has attempted such differentiation with its "Klearcor" pipe. A cross section of this pipe shows clear polyethylene on the interior wall with an outer sheath of a carbon black mixture. This is unique in that most polyethylene pipe formulations consist of a homogeneous mixture of polyethylene and carbon black throughout the pipe.

Permanent marking of the product may be another answer. Temporary marking is, of course, enough to identify the pipe with the producer for purposes of the initial sale. A real advantage could be gained through permanent marking, however. It would keep the company's name before the satisfied user and might strongly influence future sales. Also, permanent marking would prevent poor pipe from being identified with the firm. This problem is plaguing producers today. To date, no satisfactory method has been devised for permanently marking plastic pipe, however.

Quality

The pipe extruder must offer a consistently reliable product. Many of the small marginal polyethylene pipe producers who today constitute a large percentage of total plastic pipe extrusion firms do not take this long-run viewpoint. Some are manufacturing a poor quality product. They have been successful in selling this pipe largely because consumers and many distributors do not have adequate knowledge of the product. Generally, one polyethylene pipe looks like any other; low price is frequently the only criterion of pipe selection. However, this situation will not continue to exist. As polyethylene pipe failures are discovered and as these failures become identified with individual producers, the weeding-out process will be underway.

Distributors also realize that inferior pipe may be identified with their companies. They are likely to be extremely cautious about taking on new lines. Yet regional distributors are looking for a good local source of supply. In fact, this study was initiated because of the frequent statements made to this effect during the Branch's earlier survey of the plastics industry. However, the larger distributors will not buy from just any extruder. They must be assured of a consistently reliable product. They have learned the hard way. Other distributors and consumers will ultimately get the same kind of "education."

To compete against the producers of poor quality pipe, advertising and sales efforts will need to be directed toward informing the smaller retailers and users of the quality factors in pipe selection. The distributors are in the best position to acquaint consumers with product quality characteristics.

V. TRANSPORTATION

Freight rates on plastic pipe were obtained to determine the importance of freight charges in plastic pipe prices. The rates were computed for shipments to Atlanta from various origins. Atlanta was selected as a representative destination point because of its central position in the southeastern area studied in this report. The origin points were selected on the basis of geographical dispersion, taking into account the present locational pattern of the plastic pipe industry.

Freight charges on plastic pipe do not differ by type material, but by form of shipment. Rates are quoted separately on pipe shipped as coils and on that shipped as straight lengths. In carload lots, coiled pipe bears a rate approximately 155 per cent of that for straight lengths. In less-than carload lots, coiled pipe rates are about 120 per cent of those for straight lengths. Carload requirements are, for coiled pipe, 20,000 pounds, and for straight lengths, 30,000 pounds.

Comparative figures were computed for one inch polyethylene, PVC and ABS pipe. Table 2 is a tabular summary of these rates expressed as a per cent of pipe price. Prices to jobbers and distributors were used since these are the sales figures for the pipe extruders.

Scrap Polyethylene

Transportation charges on polyethylene pipe made from scrap material is an important part of distributor's cost. In order to reach the southeastern market an extruder located in the nearest concentration of plastic pipe producers--Ohio--is paying transportation charges on carload lots that approach six per cent of gross sales. On lots of less than 20,000 pounds a producer located at Columbus, Ohio pays seven per cent of gross sales to reach this market--eight per cent if he is in Cleveland.

Extruders with plants in the other principal area of concentration, New York and New Jersey, must absorb even larger transportation costs in shipping to Atlanta. These manufacturers are paying freight charges of over six per cent on carload lots and about nine per cent on less-than-carload lots.

Again using Atlanta to illustrate comparative costs, a producer here could serve an area roughly outlined by the boundaries of the South Atlantic and East Central states at a cost of less than five per cent of gross sales on carload shipments. Using rail facilities, he could distribute scrap

Table 2

PLASTIC PIPE FREIGHT RATES TO ATLANTA
PER CENT OF SELLING PRICE

| Origins | Polyethylene | | | | ABS | | PVC | |
|--------------------|--------------|------|--------|------|-----|-----|-----|-----|
| | Scrap | | Virgin | | LCL | CL | LCL | CL |
| | LCL | CL | LCL | CL | | | | |
| Los Angeles, Cal. | 17.2 | 14.9 | 12.2 | 10.6 | 8.0 | 4.5 | 4.8 | 2.7 |
| Denver, Colo. | 12.4 | 8.7 | 8.8 | 6.2 | 4.9 | 2.6 | 2.9 | 1.6 |
| Boston, Mass. | 10.4 | 7.3 | 7.4 | 5.2 | 4.1 | 2.2 | 2.5 | 1.3 |
| New York, N. Y. | 9.1 | 6.4 | 6.5 | 4.5 | 3.6 | 1.9 | 2.2 | 1.1 |
| Tulsa, Okla. | 9.0 | 6.3 | 6.4 | 4.5 | 3.5 | 1.9 | 2.1 | 1.1 |
| Dallas, Tex. | 9.0 | 6.3 | 6.4 | 4.5 | 3.5 | 1.9 | 2.1 | 1.1 |
| Chicago, Ill. | 8.2 | 5.8 | 5.9 | 4.1 | 3.3 | 1.7 | 2.0 | 1.0 |
| Cleveland, O. | 8.1 | 5.7 | 5.8 | 4.0 | 3.2 | 1.7 | 1.9 | 1.0 |
| Miami, Fla. | 7.8 | 5.4 | 5.6 | 3.9 | 3.1 | 1.6 | 1.8 | 1.0 |
| Washington, D. C. | 7.5 | 5.3 | 5.4 | 3.8 | 3.0 | 1.6 | 1.8 | 0.9 |
| St. Louis, Mo. | 7.4 | 5.2 | 5.3 | 3.7 | 2.9 | 1.6 | 1.8 | 0.9 |
| Columbus, O. | 7.2 | 5.1 | 5.2 | 3.6 | 2.9 | 1.5 | 1.7 | 0.9 |
| Huntington, W. Va. | 6.6 | 4.6 | 4.7 | 3.3 | 2.6 | 1.4 | 1.6 | 0.8 |
| Louisville, Ky. | 6.3 | 4.4 | 4.5 | 3.1 | 2.5 | 1.3 | 1.5 | 0.8 |
| Gulfport, Miss. | 6.1 | 4.3 | 4.4 | 3.1 | 2.4 | 1.3 | 1.5 | 0.8 |
| Memphis, Tenn. | 6.0 | 4.2 | 4.3 | 3.0 | 2.4 | 1.3 | 1.4 | 0.8 |
| Danville, Va. | 6.0 | 4.2 | 4.3 | 3.0 | 2.4 | 1.3 | 1.4 | 0.8 |
| Charleston, S. C. | 5.3 | 3.7 | 3.8 | 2.6 | 2.1 | 1.1 | 1.2 | 0.7 |
| Brunswick, Ga. | 4.9 | 3.4 | 3.5 | 2.4 | 1.9 | 1.0 | 1.2 | 0.6 |
| Knoxville, Tenn. | 4.2 | 3.0 | 3.0 | 2.1 | 1.7 | 0.9 | 1.0 | 0.5 |
| Birmingham, Ala. | 4.0 | 2.8 | 2.9 | 2.0 | 1.5 | 0.8 | 0.9 | 0.5 |

polyethylene pipe over about half of the southeastern states at a cost of less than five per cent of gross sales on less-than-carload shipments.

Virgin Polyethylene

Transportation charges on virgin polyethylene pipe are not quite so large a proportion of the extruder's price. Ohio producers are paying transportation costs of five or six per cent of sales to serve the southeastern market by less-than-carload shipments. Carload charges on this pipe amount to about four per cent of gross sales. To reach the southeastern market, New York-New Jersey area producers are paying four to five per cent on carload lots, six to seven per cent on LCL shipments. An Atlanta producer could serve a market roughly outlined by the South Atlantic and East South Central states for five per cent or less of gross sales on less-than-carload shipments.

ABS and PVC

Freight charges are less important for ABS and PVC pipe for two reasons: (1) the relatively higher value per pound of these pipes; (2) these pipes have a lower freight rate, since they are shipped as straight lengths. The combined effect of these two factors can be seen when Table 2 is studied.

The savings of one to three per cent of gross sales which a southeastern location provides would be of less significance for ABS and PVC than for scrap and virgin polyethylene. But in the marketing of ABS and PVC pipe, other factors become more important. The scope of the sales organization and vigor of sales effort are the principal elements in the extruder's development of the markets for these pipe products.

Conclusions

Of the four categories of plastic pipe discussed in this section, scrap polyethylene is the most important to the southeastern area. The volume of sales for this material far exceeds that of any of the other three types of pipe. And, in reviewing the data presented it is clear that a Georgia producer would enjoy a transportation cost advantage over most of the pipe producers in serving this large and growing southeastern market.

Again, in the case of virgin polyethylene pipe, transportation costs are significant. And, as southeastern consumers can be expected to increase their proportionate purchases of this pipe, more attention must be paid to these figures.

With the aid of these cost advantages the producer can establish his business on a base of polyethylene pipe production. Having done so he will be in a commanding position with respect to ABS and PVC pipes, also. For example, most distributors purchase both polyethylene and ABS pipe from one supplier. As polyethylene sales are generally the more important of the two, the decision of which supplier to trade with rests almost entirely on factors relating to the purchase of the polyethylene pipe.

VI. EQUIPMENT

An introduction to the equipment required for production of plastic pipe is presented below for those not familiar with the industry.

The Extrusion Machine

The extruder, the basic piece of equipment, consists essentially of four components: a feed hopper, a heated cylinder, a revolving screw, and a die. An extrusion compound is introduced into the machine through the feed hopper, which gravity feeds the material to the back end of the screw. The material is then forced through the cylinder by the screw so that the compound is mixed and heated. As the material is forced out of the machine it is shaped into the desired form by the die.

Extruders are identified by screw diameter and length. Common sizes range from screw diameters of $1\frac{1}{2}$ inches to six inches. The ratio of screw length to diameter (L/D ratio) is used for designation of overall size. The majority of extruders manufactured today have a 20:1 L/D ratio.

Choice of machine will, of course, depend greatly on machine capacity or "through-put." This characteristic varies principally with screw size and type of material. Other factors determining extruder capacity include L/D ratios and size and shape of parts being extruded. Screw size does not limit pipe size; for example, a $2\frac{1}{2}$ inch machine can extrude six inch pipe. However, the producer must determine the most efficient machine size for the pipe dimensions he intends to extrude. The $2\frac{1}{2}$ inch machine referred to above would extrude six inch pipe at too slow a rate to be economical.

The optimum machine for the production of a full range of polyethylene pipe up to and including four inch pipe is probably the $3\frac{1}{2}$ inch size. For pipe sizes exceeding four inches a larger machine is required for economical operation. Actually, the four inch pipe would itself probably be most profitably produced on an extrusion machine with a screw size of about $4\frac{1}{2}$ inches.

The principal advantage of the extrusion process over the molding process is continuous output. Once set up and adjusted, an extruding machine can operate on a 24-hour basis without intermittent stopping and handling by workers. The key to the return on investment is the maximization of the number of pounds of acceptable end product processed per hour. The problem of choice of machine size is not just a matter of obtaining maximum throughput per dollar of investment. The difficulties in controlling pipe quality must also be considered.

A six-inch machine would provide a rapid extrusion rate for, say, one inch polyethylene pipe, but the process could not be properly controlled at this rate. As a producer gains experience he can increase extrusion rates somewhat and still produce a quality product, but he cannot expect to operate his machine at the full extrusion rate for all pipe sizes.

Though it is often possible to run different materials through an extruder without modification, optimum results are obtained when a specially designed screw is used for each material family. There are interchangeable specialized screws available to fit any size extrusion machine. Screws for the processing of polyethylene, ABS and PVC are obtainable in the 3½ inch size at a cost of from \$1,000 to \$1,500 each.

The interchangeability of the screws allows easy production changeover from one material to another. One extrusion machine is sufficient basic equipment for the production of all three types of pipe discussed in this report. The change in the production setup requires more than just changing screws, of course. Take-off procedures must also be modified. Each material must be treated individually. But the set-up changes are easily accomplished. The pipe extruder can produce each type of pipe intermittently.

No attempt is made here to detail all of the factors associated with extrusion machine design and selection. There are so many variable factors that must be taken into consideration that the prospective purchaser must know exactly what his requirements are going to be. With this information, he can approach several manufacturers and carefully weigh the data obtained from each. Factors related to the choice of an extruder other than those mentioned above, include heating methods, heating controls, venting and die attachment. Some comparative technical data on extrusion machines were published in the September 1958 issue of Plastics Technology, pages 817 through 828.

Auxiliary Equipment

In addition to the basic extrusion machine, a typical pipe extrusion setup includes appropriate sizing and cooling facilities, a pulling device and coiling or cut-off equipment. Several methods are in current use for sizing and cooling the pipe as it leaves the die. Polyethylene pipe, for example, may be drawn through a cooling sleeve which forces the pipe over an internally cooled, tapered mandrel, or it may be drawn through a water trough which contains a series of sizing plates. The trough is generally from five to 20 feet in length.

This operation insures proper pipe size and hardens the material in its final shape. Other pipe materials are frequently air cooled.

The pipe next passes through the pulling, or haul-off, device which must be accurately set to maintain proper tension on the pipe extrudate. The tension provided by the haul-off device must, of course, be synchronized with the extrusion rate of the machine. After passing through the haul-off unit, flexible pipe is wound on a coiling machine which consists of one or two large reels. Rigid pipe is automatically measured and cut to the desired length. In some cases, the cutting operation is performed by the haul-off unit.

Other accessory equipment includes the hopper dryer for removal of moisture from the raw material. This equipment is of particular importance in humid areas. A pipe marking unit may be desirable for trade-mark printing on the finished product. Finally, a basic plant layout must include provision for compressed air and necessary electrical lead-ins and switches.

A typical polyethylene pipe production layout, showing the basic operation, is diagrammed on the following page.

Credit Availability

Purchase terms available for plastics processing equipment do not differ from those generally found in other industries for machinery of comparable cost. One fourth to one third of the purchase price is normally required as a down payment by the machinery manufacturers.

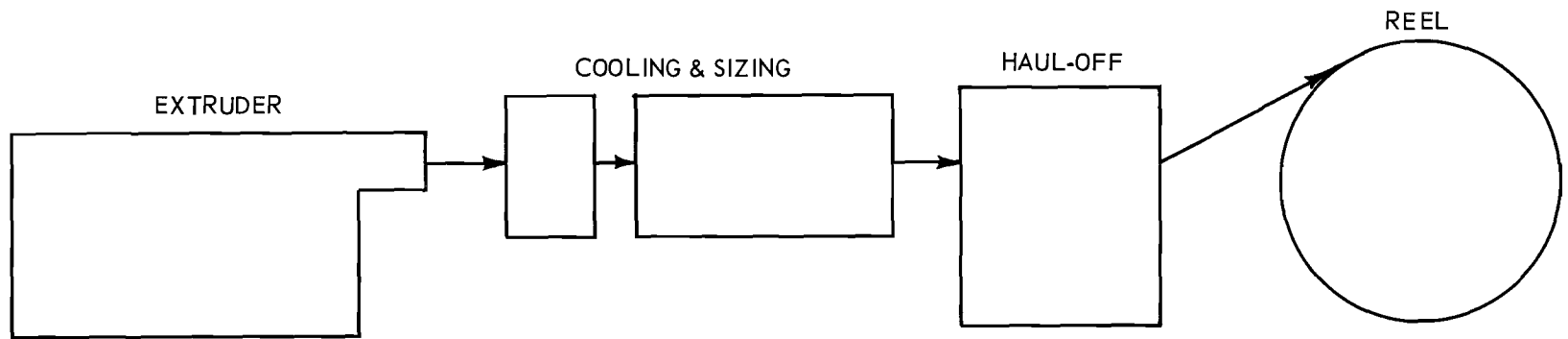
Alternately, the facilities of commercial lending institutions may be used. Loans from such companies may be obtained for periods of four or five years. Interest charges by both equipment manufacturers and commercial lending institutions may be estimated at six per cent of the unpaid balance.

Technological Improvement

The production of plastic pipe is by no means a standardized operation. The basic equipment remains generally the same but each producer develops his own techniques and procedures. Techniques are an important factor in increasing extrusion rates while maintaining proper quality control. Cooling and sizing methods are highly individualized and cause quality differences. The extruder will no doubt be constantly striving for technological improvement.

A recent interesting development is the extrusion of two or more sizes of pipe concurrently from a single die. The economies are obvious. On

CHART 2: POLYETHYLENE PIPE EXTRUSION PROCESS
(Block Diagram)



this technique, Modern Plastics writes: "With proper die design there is no reason why up to a dozen pipelines cannot be made at the same time."¹/

¹/ "The Economics of Plastic Extrusion," Vol. 35, Nov. 1957, p. 234.

VII. OPERATIONS

The balance sheet on page 36 shows the relationship that may be expected among the assets, liabilities, and net worth of a pipe extruder. Although this statement is not intended to be representative of an existing firm, it does have a basis in fact.

Assuming only one extrusion machine and enough accessory equipment to provide a reasonably flexible product mix, the investment in fixed assets is estimated at \$35,000. This figure is neither a minimum nor a maximum value for an operation involving one extrusion machine. Upon the assignment of a value to fixed assets, the remainder of the accounts were valued by using relationships that actually exist in the plastics processing industry. These relationships were taken from data published by the Tarnell Company. The result is the estimated balance sheet of a prototype extruder.

The income statement presented on page 37 is a rough estimate of what may be expected in the way of costs relative to revenue. It is somewhat more conservative than that compiled by Monsanto Chemical Company in its 1955 report.^{1/} That report showed before-tax profit figures in excess of 18 per cent of the processor's sales. However, the present competitive situation does not indicate that such profit rates still prevail. Actually, the extrusion process allows such a large throughput volume per dollar of investment that a high return on sales is not required.

A new producer would naturally expect his cost percentages to exceed these figures for a time. Aside from experimentation costs and inefficiencies inherent in a new enterprise, selling expense will take a larger share of the sales dollar than is indicated here. Future reductions may be expected in raw material prices, but until the competitive situation is improved there is little likelihood of their being reflected in the profit figure. (There is constant downward pressure on pipe prices. This is an exceedingly competitive industry.)

Production Information

As noted previously, it is not possible to compute a production figure without first knowing a great deal of specific technical information. Throughput on an extruder varies with type of material, screw size, product size, take-

^{1/} "Pipelines to the Future: A Study of Plastic Pipe."

PIPE EXTRUDER
BALANCE SHEET--ONE EXTRUSION MACHINE

ASSETS:

| | |
|---------------------|------------------|
| Cash | \$ 10,000 |
| Accounts Receivable | 25,000 |
| Inventory | 25,000 |
| Fixed Assets | 35,000 |
| Other Assets | <u>5,000</u> |
| | <u>\$100,000</u> |

LIABILITIES & NET WORTH:

| | |
|---------------------------|------------------|
| Accounts Payable | \$ 15,000 |
| Other Current Liabilities | 18,000 |
| Term Debt | 10,000 |
| Net Worth | <u>57,000</u> |
| | <u>\$100,000</u> |

PIPE EXTRUDER
INCOME STATEMENT

| | | |
|---------------------------------------------------|-----------|------------------|
| Net Sales | | 100% |
| Cost of Goods Sold: | | |
| Material | 55% | |
| Conversion | <u>17</u> | |
| Total Cost of Goods Sold | | <u>72</u> |
| Gross Profit | | 28% |
| Selling Expense | 9% | |
| General and Administrative Expense | <u>10</u> | |
| Total Selling, General and Administrative Expense | | <u>19</u> |
| Profit before Taxes | | 9% |
| Taxes | | <u>4</u> |
| Net Profit | | <u><u>5%</u></u> |

off technique, quality limits and experience. For purposes of illustration, however, a rough estimate has been attempted.

For an average pipe size, a 3½ inch extrusion machine can be expected to process polyethylene at a rate of approximately 125 pounds an hour. Operating 16 hours a day, as many extruders do, this throughput rate gives a daily production of 2,000 pounds. If maintained five days a week, this daily production would return between \$200,000 and \$300,000 annually in gross sales of scrap polyethylene. The processing of virgin polyethylene or any of the other pipe materials would result in a considerable increase in this estimate.

The pipe manufacturer must offer a range of sizes in each type of pipe. Here are some representative size offerings of present firms:

| <u>Polyethylene</u> | <u>PVC</u> | <u>ABS</u> |
|---------------------|------------|------------|
| 1/2 in. | 1/4 in. | 3/4 in. |
| 3/4 | 3/8 | 1 |
| 1 | 1/2 | 1 1/4 |
| 1 1/4 | 3/4 | 1 1/2 |
| 1 1/2 | 1 | 2 |
| 2 | 1 1/4 | 2 1/2 |
| 2 1/2 | 1 1/2 | 3 |
| 3 | 2 | 4 |
| 4 | 2 1/2 | 6 |
| 6 | 3 | |
| | 4 | |
| | 5 | |
| | 6 | |
| | 8 | |

Labor

The operation of the plant requires one key production man. Other workers are not critical, agricultural and textile hands can be easily trained for this work. The supervisor will have to be brought in from an existing operation or from some other source outside the Southeast, since there are at present very few trained extrusion technicians in this area.

Many pipe extrusion firms begin operations without such a technician. However, the importance of early emphasis on quality has already been emphasized. If the producer can create confidence in his product in the eyes of

the distributors there is no reason why he cannot capture a large percentage of the local market in a short time. An experienced technician is necessary to the creation of this confidence. His salary should be more than offset by attainment early of volume operations and through waste reduction.

Development of the Business

Pipe of polyethylene material is a starting point for the prospective extruder. The volume of sales for polyethylene pipe has been shown to be of such magnitude as to allow the early establishment of a reasonable production output. The extruder can get into operation, work out the "bugs" and market an acceptable product within a reasonable time. ABS pipe is the next logical addition to the product line. A substantial amount of this pipe passes through the same distribution channels as the polyethylene pipe. In fact, it is almost a necessary co-product in selling to the leading distributors.

A next step might be the development of other channels for polyethylene and especially the ABS pipe. After lines of distribution have been opened to industrial users, the producer is in a position to add PVC pipe to the product mix if he desires. When he has accomplished this, the extruder will have established himself as a producer of the plastic pipes with volume markets.

At some time in the development of the business the producer may wish to take any of a number of supplementary or complementary lines of action. Larger profits can be made in more specialized pipes. Butyrate, nylon, polypropylene, the polyfluorocarbons and other materials are presently being used for limited pipe applications. The petroleum, gas, chemical and chemical processing industries in the South are a growing market for such products. A producer located close to textile and paper plants can offer a much needed service to these industries by evaluating their requirements and supplying their needs. Outstanding profit possibilities already exist here; others can be expected to develop at an increasing rate.

Other opportunities are to be found in a multitude of extruded shapes. Florida is a center of extruded plastic weatherstripping production. Architectural shapes are a growing market. Continuing efforts are being devoted to adapting present molded products to extrusion because of the economies offered by the latter process. After the extruder has mastered the techniques of production and has developed a going business, almost unlimited product possibilities are available for diversification, expansion, and profit.

Appendices

Appendix Table 1
PLASTIC PIPES--COMPARATIVE TECHNICAL DATA

| <u>CHARACTERISTIC</u> | <u>POLYETHYLENE</u> | <u>ABS</u> | | <u>PVC</u> | |
|-----------------------------------------------------|---------------------|----------------|-------------|---------------|----------------|
| | | <u>REGULAR</u> | <u>HTHT</u> | <u>TYPE I</u> | <u>TYPE II</u> |
| Maximum operating temperature (F.) | 120 | 165 | 180 | 150 | 130 |
| Specific gravity | 0.93 | 1.06 | 1.08 | 1.38 | 1.35 |
| Tensile strength (p.s.i. at 75° F.) | 1500 | 5000 | 8000 | 7000 | 6000 |
| Impact strength (Ft. lbs./in. notch) | over 16 | 5-9 | 4.5 | 0.88 | 10 |
| Hardness (Rockwell) | 11 | 96 | 110 | 115 | 107 |
| Dielectric strength (1/8 x volts/mil) | 460 | 312 | 312 | 177 | 138 |
| Thermal expansion (10 ⁻⁵ in./in./deg.F.) | 9 | 5.6 | 5.6 | 3 | 5 |
| Elongation (% at 75° F.) | 500 | 40 | 25 | 50 | 30 |

SOURCE: Above data taken from manufacturers' literature. Figures are representative.

Appendix Table 2
 PLASTIC PIPE--COMPARATIVE PRICES^{1/}

| <u>SPECIFICATION</u> | <u>POLYETHYLENE</u> | | <u>ABS</u> | <u>PVC</u> |
|----------------------|---------------------|---------------|------------|------------|
| | <u>SCRAP</u> | <u>VIRGIN</u> | | |
| Schedule 40 | .17 | .22 | . | .75 |
| 75 lb. | .24 | .31 | | |
| 100 lb. | .40 | .52 | .20 | |
| 125 lb. | | | .26 | |
| 150 lb. | | | .25 | |
| 150 lb. deep well | | | .37 | |
| 200 lb. | | | .40 | |
| Schedule 80 | | | .85 | .99 |
| Schedule 120 | | | | 1.08 |

^{1/} Representative jobber and industrial list prices per foot for 1½ inch, plain end pipe.

Appendix A

EXTRUSION MACHINE MANUFACTURERS^{1/}

Baker Perkins, Inc., 1000 Hess Street, Saginaw, Mich.
Comerio Ercole S. P. A., Via S. Pellico, 3, Busto Arsizio, Italy.
Davis-Standard, Division of Franklin Research Corporation, 14 Water Street, Mystic, Conn.
Frank W. Egan & Company, 115 Lincoln Boulevard, Bound Brook, N. J.
Erie Foundry Company, 1253 W. 12th Street, Erie 6, Pa.
Fabbrica Prodotti Termoplastici Carlo Pasquetti, Sanvito Silvestro 103, Varese-Masnago, Italy.
Farrel-Birmingham Company, Inc., Ansonia, Conn.
General Engineering Company (Radcliffe Ltd.), Station Works, Bury Road, Lancaster, Lancashire, England.
Guild Electronics, Inc., Dynatherm Division, 388 Broadway, New York, N. Y.
Hale & Kullgren, Inc., Aetna-Standard Engineering Company Division, 613 E. Tallmadge Avenue, Akron, O.
Hartig Engine & Machine Company, 448 Hillside Avenue, Hillside, N. J.
H. H. Heinrich Company, 111 Eighth Avenue, New York 11, N. Y.
Hermann Bertorff Maschinenbau-Anstalt G. M. B. H., An der Breiten Wiese, Hanover, W. Germany.
Karlton Machinery Corporation, 210 E. Ohio Street, Chicago 11, Ill.
Killion Tool & Manufacturing Company, 56 Depot Street, Verona, N. J.
Loomis Engineering & Manufacturing Company, 126 S. 14th Street, Newark 7, N. J.
Marine Plastics, Inc., School Street, Clinton, Mass.
Modern Plastic Machinery Corporation, 15 Union Street, Lodi, N. J.
National Rubber Machinery Company, 47 W. Exchange Street, Akron 8, O. (Southern distributor: The Robertson Company, Rutland Building, Decatur, Ga.)
Negri, Bossi & Company, Corso Magenta 44, Milano, Italy.
Peco Machinery Sales (Westminster) Ltd., 28 Victoria Street, London S. W. 1, England.
Prodex Corporation, Fords, N. J.
Reed-Prentice Corporation, 677 Cambridge Street, Worcester 4, Mass.
A. Reifenhauer, Troisdorf Bez-Koln, Germany.
Rolis, Inc., 1240 E. 14th Street, Brooklyn, N. Y.

^{1/} From: Directory, Modern Plastics Encyclopedia, p. 1043.

John Royle & Sons, 10 Essex Street, Paterson 39, N. J.

Francis Shaw & Company, Ltd., Corbett Street, Manchester 11, England.

Sherman Rubber Machinery Company, 2 Sherman Street, Worcester 1, Mass.

F. J. Stokes Corporation, 5500 Tabor Road, Philadelphia 20, Pa.

(Atlanta office: 1300 N. Cross Keys Drive, N.E.)

Welding Engineers, Inc., P. O. Box 391, Norristown, Pa.

R. H. Windsor, Ltd., Leatherhead Road, South Chessington, Surrey, England.

Appendix B
MATERIAL SUPPLIERS^{1/}

Polyethylene

Alpha Chemical & Plastics Corporation, 11 Jabez Street, Newark 5, N. J.
Bakelite Company, Division, Union Carbide Corporation, 30 E. 42nd Street,
New York 17, N. Y.
The Dow Chemical Company, Midland, Mich.
E. I. du Pont de Nemours & Company, Inc., Wilmington 98, Del.
Eastman Chemical Products, Inc., Sub., Eastman Kodak Company, Kingsport, Tenn.
Fiberfil, Inc., Fox Farm Road, Warsaw, Ind.
Gering Products Inc., Kenilworth, N. J.
Monsanto Chemical Company, Springfield, Mass.
Phillips Chemical Company, Adams Building, Bartlesville, Okla.
Semet-Solvay Petrochemical Division, Allied Chemical Corporation,
40 Rector Street, New York 6, N. Y.
U. S. Industrial Chemicals Company, Division, National Distillers & Chemical
Corporation, 99 Park Avenue, New York 16, N. Y.

Polyvinyl Chloride

Alpha Chemical & Plastics Corporation, 11 Jabez Street, Newark 5, N. J.
Bakelite Company, Division, Union Carbide Corporation, 30 E. 42nd Street,
New York 17, N. Y.
The Blane Corporation, 38 Pequit Street, Canton, Mass.
Borden Chemical Company, Division, The Borden Company, 350 Madison Avenue,
New York 17, N. Y.
Chemical Products Corporation, King Philip Road, East Providence 14, R. I.
Chemore Corporation, 21 West Street, New York 6, N. Y.
The Dow Chemical Company, Midland, Mich.
Escambia Chemical Corporation, 261 Madison Avenue, New York 16, N. Y.
Firestone Plastics Company, P. O. Box 69, Pottstown, Pa.
The General Tire & Rubber Company, Chemical Division, 1708 Englewood Avenue,
Akron 9, O.
Gering Products Inc., Kenilworth, N. J.
B. F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, O.

^{1/} From: Plastics World, Vol. 16 (9/58).

Goodyear Tire & Rubber Company, Chemical Division, 1485 Archwood Avenue,
Akron 16, O.

Michigan Chrome & Chemical Company, 8615 Grinnell Avenue, Detroit 5, Mich.

Monsanto Chemical Company, Springfield, Mass.

Naugatuck Chemical Division, U. S. Rubber Company, Naugatuck, Conn.

Resin-Rubber Blends

The Dow Chemical Company, Midland, Mich.

Foster Grant Company, Inc., Polymer Products Division, Leominster, Mass.

B. F. Goodrich Chemical Company, 3135 Euclid Avenue, Cleveland 15, O.

Isochem Resins Corporation, 221 Oak Street, Providence 9, R. I.

Monsanto Chemical Company, Springfield, Mass.

Naugatuck Chemical Division, U. S. Rubber Company, Naugatuck, Conn.